MSCSM120HRM052NG

T-Type SiC MOSFET Power Module

Product Overview

The MSCSM120HRM052NG device is a T-type Silicon Carbide (SiC) MOSFET power module with a phase leg 1200V, 472A and a dual common source 700V, 442A.

The following figures show the electrical and pinout location diagrams of the device.

Figure 1. Electrical Diagram

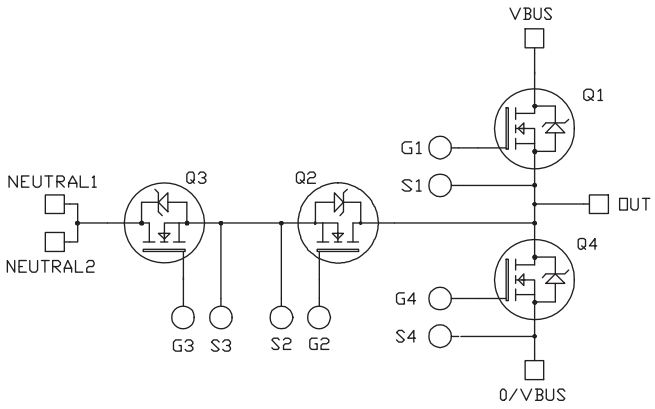
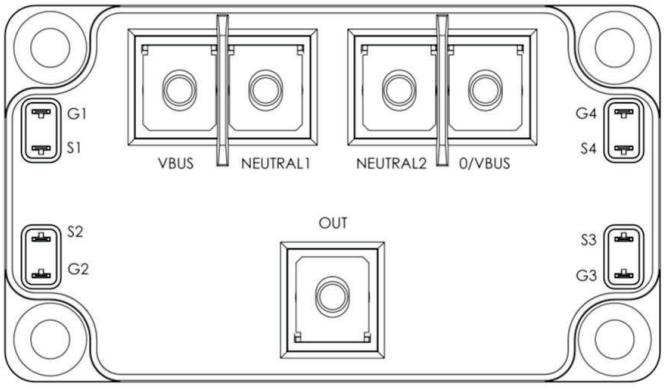


Figure 2. Pinout Location Diagram



Note: All ratings at T_J = 25 °C, unless otherwise specified.

⚠ **CAUTION** These devices are sensitive to electrostatic discharge. Proper handling procedures must be followed.

Features

The MSCSM120HRM052NG device has the following features:

- SiC Power MOSFET
  - Low $R_{DS(on)}$
  - High temperature performance
- Kelvin source for easy drive
- Low stray inductance
- M5 power connectors
- High level of integration
- Si_3N_4 substrate for improved thermal performance

Benefits

The MSCSM120HRM052NG device has the following benefits:

- Outstanding performance at high-frequency operation
- Direct mounting to heatsink (isolated package)
- Low junction-to-case thermal resistance
- Low profile
- RoHS compliant

Applications

The MSCSM120HRM052NG device has the following applications:

- Solar inverter
- Three level inverter
- Uninterruptible power supplies

1. Electrical Specifications

The following sections describe the electrical specifications of the MSCSM120HRM052NG device.

1.1 Q1 and Q4 1200V Phase Leg SiC MOSFETs (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the Q1 and Q4 1200V phase leg SiC MOSFETs.

Table 1-1. Absolute Maximum Ratings: Q1 and Q4 1200V Phase Leg SiC MOSFETs

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-source voltage		1200	V
I_D	Continuous drain current	T_C = 25 °C	472	A
		T_C = 80 °C	376	
I_{DM}	Pulsed drain current		940	
V_{GS}	Gate-source voltage		−10/23	V
$R_{DS(on)}$	Drain-source ON resistance		5.2	mΩ
P_D	Power dissipation	T_C = 25 °C	1846	W

The following table lists the electrical characteristics (per SiC MOSFET) of the Q1 and Q4 1200V phase leg SiC MOSFETs.

Table 1-2. Electrical Characteristics: Q1 and Q4 1200V Phase Leg SiC MOSFETs

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0V; V_{DS} = 1200V		—	60	600	µA
$R_{DS(on)}$	Drain-source ON resistance	V_{GS} = 20V	T_J = 25 °C	—	4.2	5.2	mΩ
		I_D = 240A	T_J = 175 °C	—	6.7	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 18 mA		1.8	2.8	—	V
I_{GSS}	Gate-source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	600	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the Q1 and Q4 1200V phase leg SiC MOSFETs.

Table 1-3. Dynamic Characteristics: Q1 and Q4 1200V Phase Leg SiC MOSFETs

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	18.1	—	nF
C_{oss}	Output capacitance	V_{DS} = 1000V		—	1.6	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.15	—	
Q_g	Total gate charge	V_{GS} = −5V/20V		—	1392	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 800V		—	246	—	
Q_{gd}	Gate-drain charge	I_D = 240A		—	300	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = −5V/20V	T_J = 150 °C	—	56	—	ns
T_r	Rise time	V_{Bus} = 600V		—	55	—	
$T_{d(off)}$	Turn-off delay time	I_D = 300A		—	166	—	
T_f	Fall time	R_{GON} = 1.3Ω R_{GOFF} = 0.8Ω		—	67	—	
E_{on}	Turn-on energy	V_{GS} = −5V/20V	T_J = 150 °C	—	7.3	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 600V I_D = 300A R_{GON} = 1.3Ω R_{GOFF} = 0.8Ω		—	5.5	—	
R_{Gint}	Internal gate resistance			—	1	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.081	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the Q1 and Q4 1200V phase leg SiC MOSFETs.

Table 1-4. Body Diode Ratings and Characteristics: Q1 and Q4 1200V Phase Leg SiC MOSFETs

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	V_{GS} = 0V; I_{SD} = 240A	—	4	—	V
		V_{GS} = –5V; I_{SD} = 240A	—	4.2	—	
t_{rr}	Reverse recovery time	I_{SD} = 240A	—	90	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = −5V	—	3300	—	nC
I_{rr}	Reverse recovery current	V_R = 800V di_F/dt = 6000 A/µs	—	81	—	A

1.2 Q2 and Q3 700V Dual Common Source SiC MOSFETs (Per SiC MOSFET)

The following table lists the absolute maximum ratings (per SiC MOSFET) of the Q2 and Q3 700V dual common source SiC MOSFETs.

Table 1-5. Absolute Maximum Ratings: Q2 and Q3 700V Dual Common Source SiC MOSFETs

Symbol	Parameter		Maximum Ratings	Unit
V_{DSS}	Drain-source voltage		700	V
I_D	Continuous drain current	T_C = 25 °C	442	A
		T_C = 80 °C	352	
I_{DM}	Pulsed drain current		884	
V_{GS}	Gate-source voltage		−10/23	V
$R_{DS(on)}$	Drain-source ON resistance		4.8	mΩ
P_D	Power dissipation	T_C = 25 °C	1161	W

The following table lists the electrical characteristics (per SiC MOSFET) of the Q2 and Q3 700V dual common source SiC MOSFETs.

Table 1-6. Electrical Characteristics: Q2 and Q3 700V Dual Common Source SiC MOSFETs

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
I_{DSS}	Zero gate voltage drain current	V_{GS} = 0V; V_{DS} = 700V		—	—	400	µA
$R_{DS(on)}$	Drain-source ON resistance	V_{GS} = 20V	T_J = 25 °C	—	3.8	4.8	mΩ
		I_D = 160A	T_J = 175 °C	—	4.8	—	
$V_{GS(th)}$	Gate threshold voltage	V_{GS} = V_{DS}; I_D = 16 mA		1.9	2.4	—	V
I_{GSS}	Gate-source leakage current	V_{GS} = 20V; V_{DS} = 0V		—	—	400	nA

The following table lists the dynamic characteristics (per SiC MOSFET) of the Q2 and Q3 700V dual common source SiC MOSFETs.

Table 1-7. Dynamic Characteristics: Q2 and Q3 700V Dual Common Source SiC MOSFETs

Symbol	Characteristic	Test Conditions		Min.	Typ.	Max.	Unit
C_{iss}	Input capacitance	V_{GS} = 0V		—	18	—	nF
C_{oss}	Output capacitance	V_{DS} = 700V		—	2	—	
C_{rss}	Reverse transfer capacitance	f = 1 MHz		—	0.11	—	
Q_g	Total gate charge	V_{GS} = −5V/20V		—	860	—	nC
Q_{gs}	Gate-source charge	V_{Bus} = 470V		—	232	—	
Q_{gd}	Gate-drain charge	I_D = 160A		—	140	—	
$T_{d(on)}$	Turn-on delay time	V_{GS} = −5V/20V	T_J = 150 °C	—	78	—	ns
T_r	Rise time	V_{Bus} = 400V		—	125	—	
$T_{d(off)}$	Turn-off delay time	I_D = 320A		—	214	—	
T_f	Fall time	R_{GON} = 18Ω R_{GOFF} = 4Ω		—	92	—	
E_{on}	Turn-on energy	V_{GS} = −5V/20V	T_J = 150 °C	—	6.6	—	mJ
E_{off}	Turn-off energy	V_{Bus} = 400V I_D = 320A R_{GON} = 18Ω R_{GOFF} = 4Ω		—	7	—	
R_{Gint}	Internal gate resistance			—	1.4	—	Ω
R_{thJC}	Junction-to-case thermal resistance			—	—	0.129	°C/W

The following table lists the body diode ratings and characteristics (per SiC MOSFET) of the Q2 and Q3 700V dual common source SiC MOSFETs.

Table 1-8. Body Diode Ratings and Characteristics : Q2 and Q3 700V Dual Common Source SiC MOSFETs

Symbol	Characteristic	Test Conditions	Min.	Typ.	Max.	Unit
V_{SD}	Diode forward voltage	V_{GS} = 0V; I_{SD} = 160A	—	3.4	—	V
		V_{GS} = −5V; I_{SD} = 160A	—	3.8	—	
t_{rr}	Reverse recovery time	I_{SD} = 160A	—	40	—	ns
Q_{rr}	Reverse recovery charge	V_{GS} = −5V	—	2	—	µC
I_{rr}	Reverse recovery current	V_R = 400V di_F/dt = 4000 A/µs	—	76	—	A

1.3 Thermal and Package Characteristics

The following table lists the package characteristics of the MSCSM120HRM052NG device.

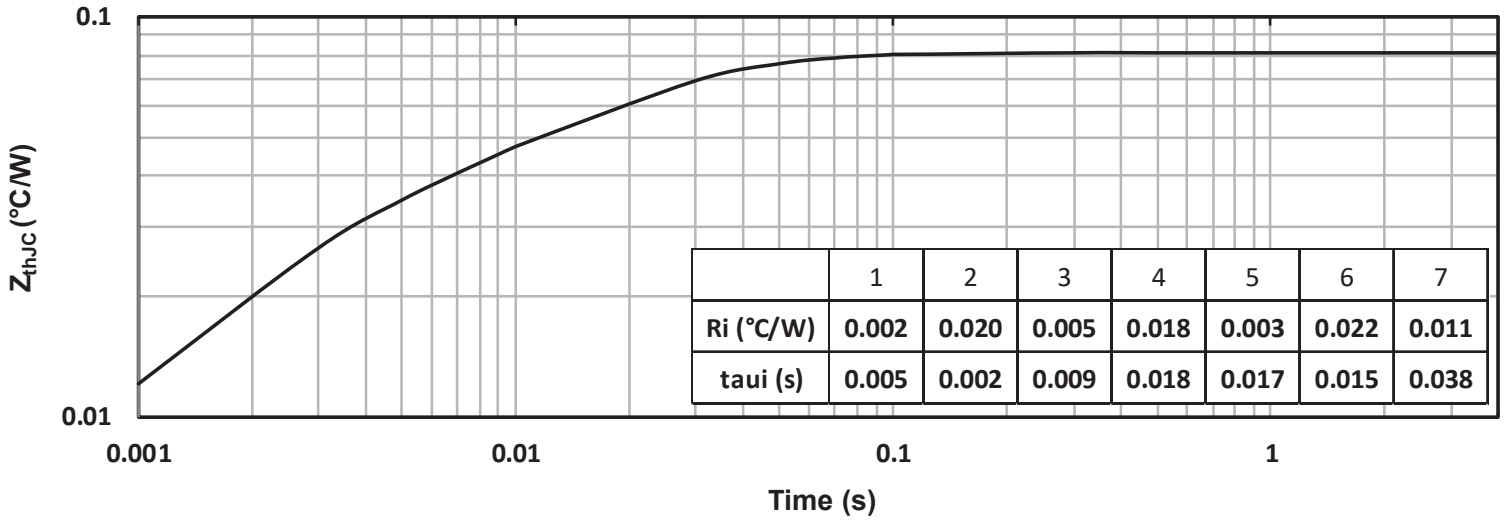
Table 1-9. Thermal and Package Characteristics

Symbol	Characteristic			Min.	Max.	Unit
V_{ISOL}	RMS isolation voltage, any terminal to case t = 1 min, 50 Hz/60 Hz			4000	—	V
T_J	Operating junction temperature range			–40	175	°C
T_{JOP}	Recommended junction temperature under switching conditions			–40	T_{Jmax}–25	
T_{STG}	Storage temperature range			–40	125	
T_C	Operating case temperature			–40	125	
Torque	Mounting torque	To heatsink	M6	3	5	N.m
		For terminals	M5	2	3.5	
Wt	Package weight			—	300	g

1.4 Typical 1200V SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the Q1 and Q4 1200V phase leg SiC MOSFETs.

Figure 1-1. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.002	0.020	0.005	0.018	0.003	0.022	0.011
taui (s)	0.005	0.002	0.009	0.018	0.017	0.015	0.038

Figure 1-2. Output Characteristics, T_J = 25 °C

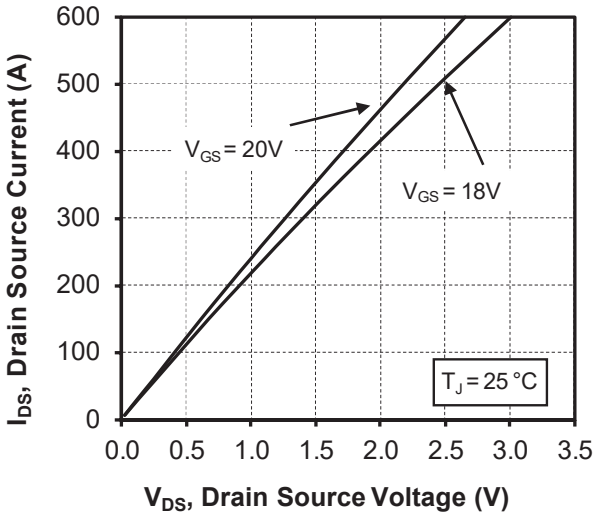


Figure 1-3. Output Characteristics, T_J = 175 °C

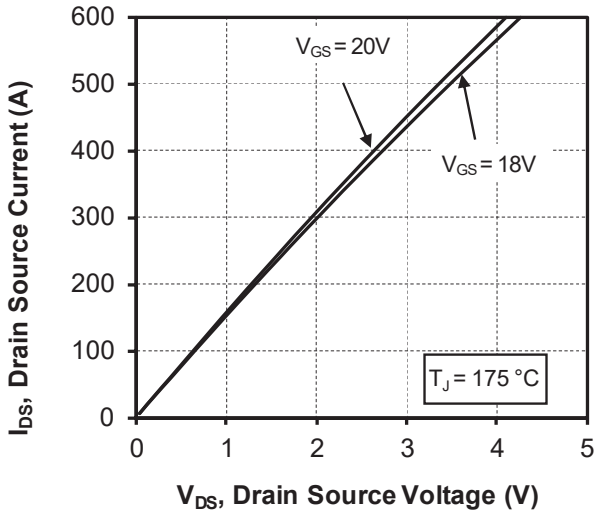


Figure 1-4. Normalized $R_{DS(on)}$ vs. Temperature

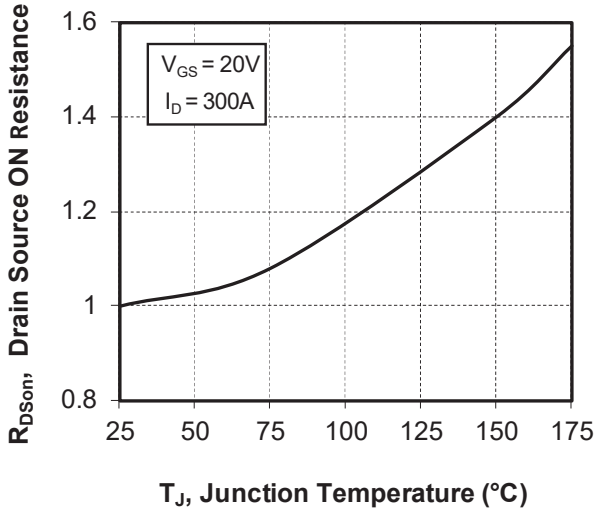


Figure 1-5. Transfer Characteristics

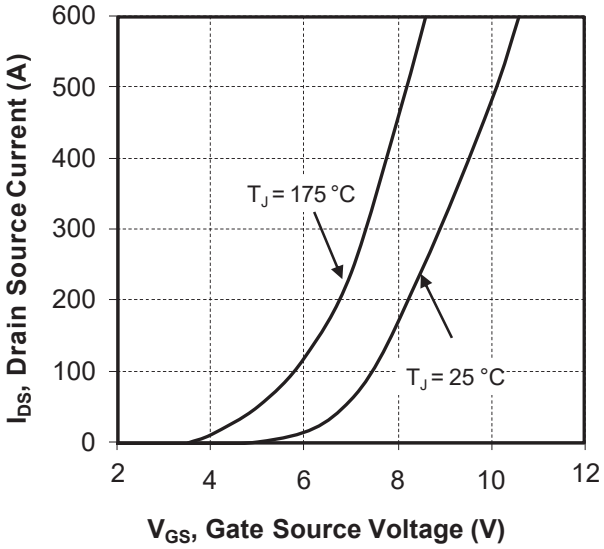


Figure 1-6. Switching Energy vs. Rg

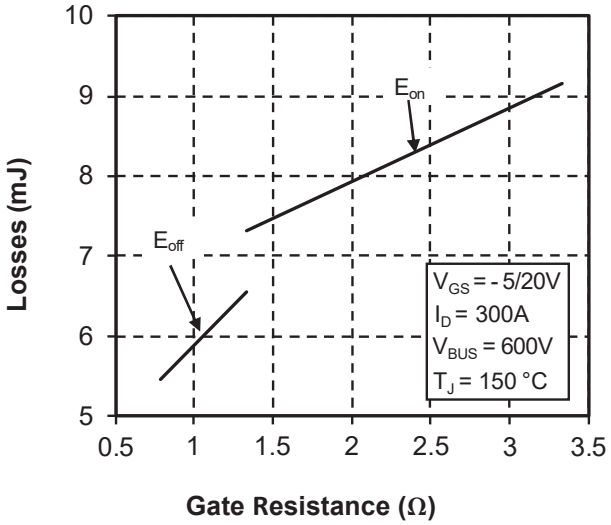


Figure 1-7. Switching Energy vs. Current

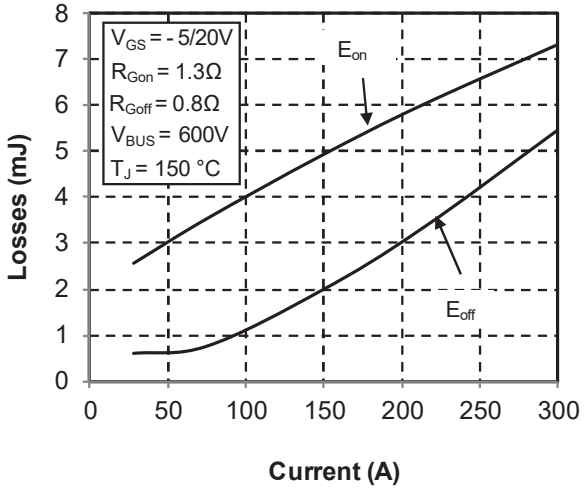


Figure 1-8. Capacitance vs. Drain Source Voltage

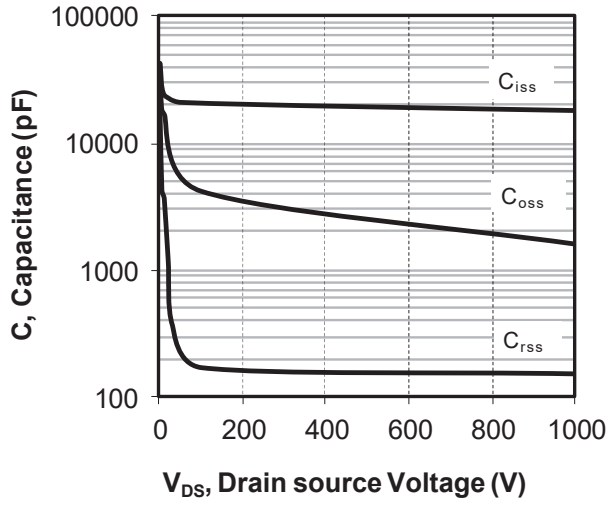


Figure 1-9. Gate Charge vs. Gate Source Voltage

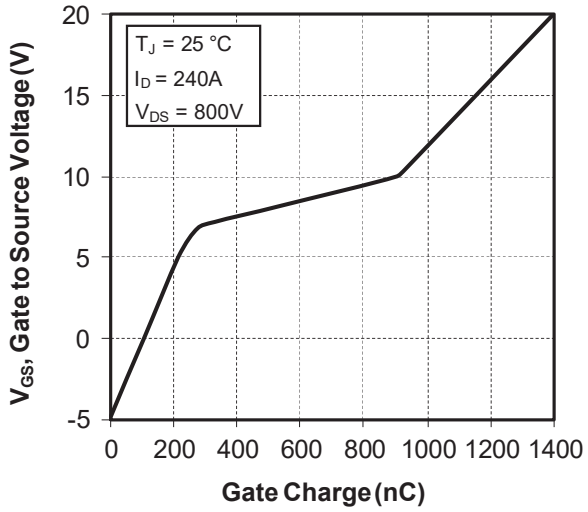


Figure 1-10. Body Diode Characteristics, T_J = 25 °C

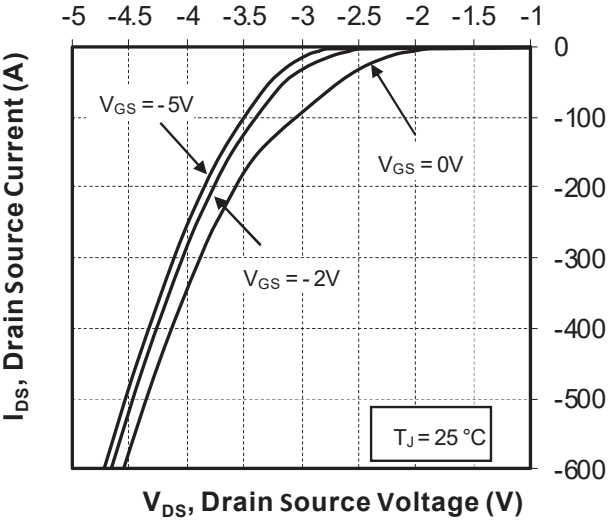


Figure 1-11. 3rd Quadrant Characteristics, T_J = 25 °C

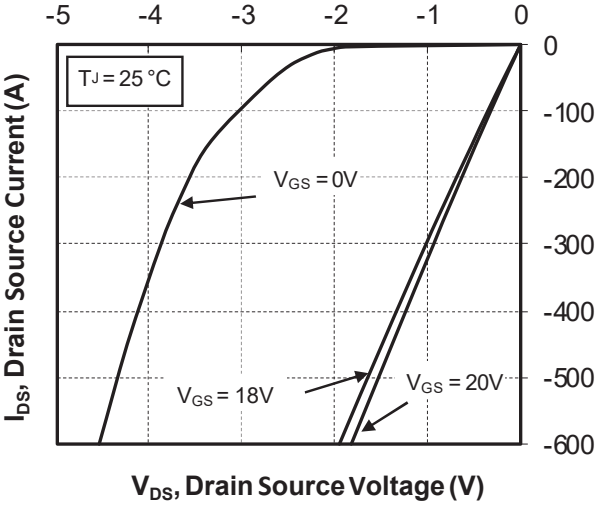


Figure 1-12. Body Diode Characteristics, T_J = 175 °C

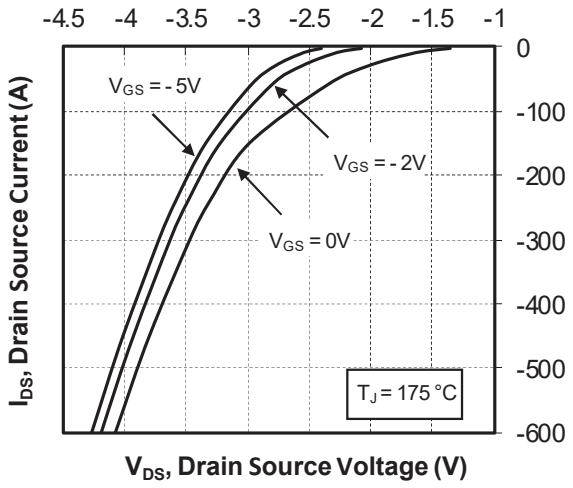


Figure 1-13. 3rd Quadrant Characteristics, T_J = 175 °C

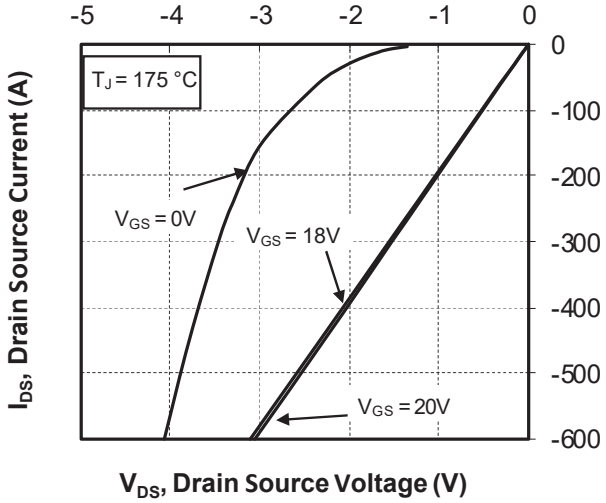
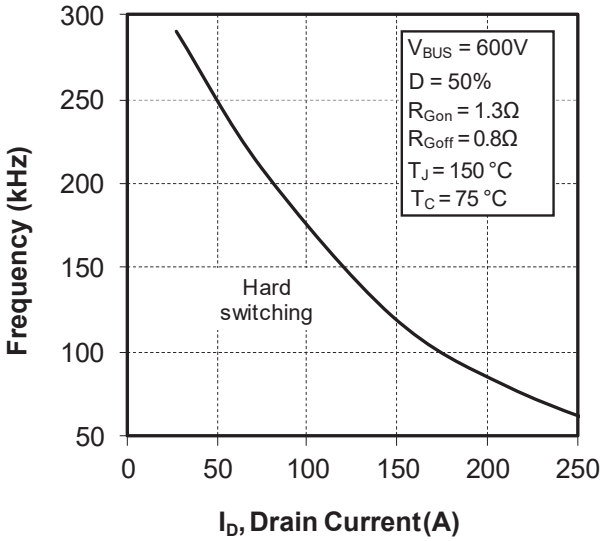


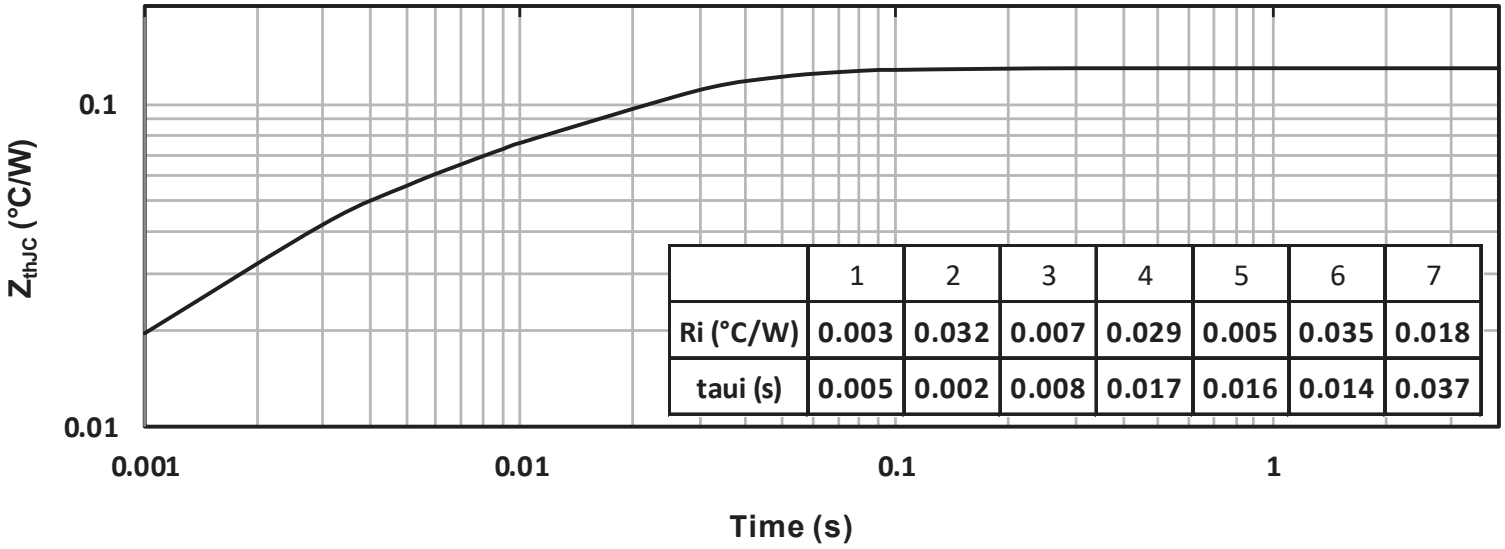
Figure 1-14. Operating Frequency vs. Drain Current



1.5 Typical 700V SiC MOSFET Performance Curve

The following figures show the SiC MOSFET performance curves of the Q2 and Q3 700V dual common source SiC MOSFETs.

Figure 1-15. Maximum Thermal Impedance



	1	2	3	4	5	6	7
Ri (°C/W)	0.003	0.032	0.007	0.029	0.005	0.035	0.018
taui (s)	0.005	0.002	0.008	0.017	0.016	0.014	0.037

Figure 1-16. Output Characteristics, T_J = 25 °C

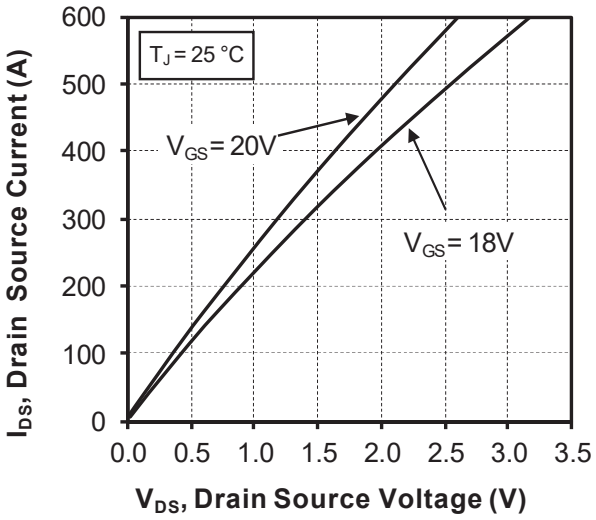


Figure 1-17. Output Characteristics, T_J = 175 °C

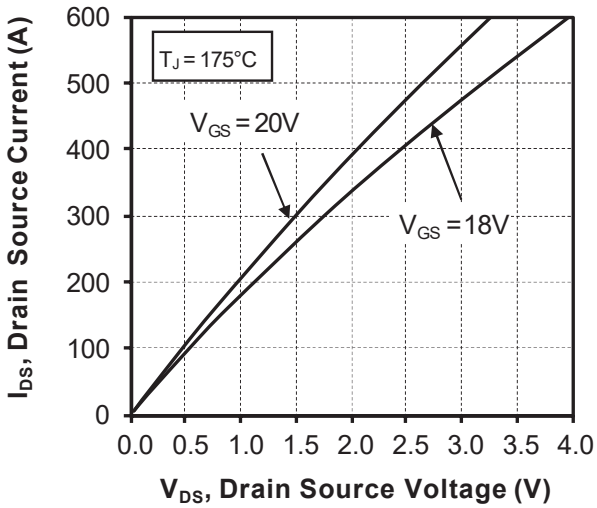


Figure 1-18. Normalized $R_{DS(on)}$ vs. Temperature

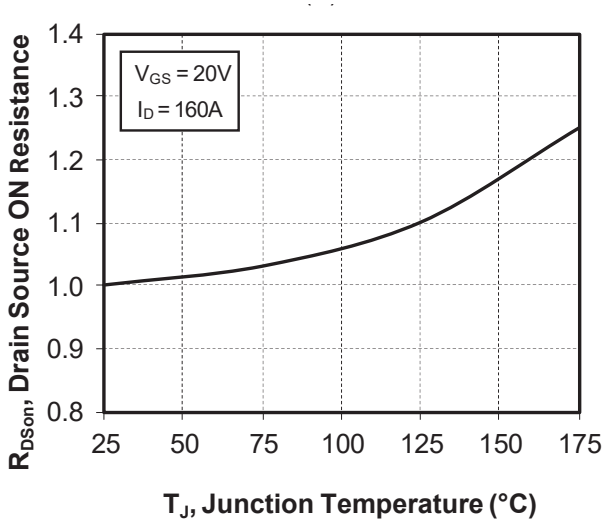


Figure 1-19. Transfer Characteristics

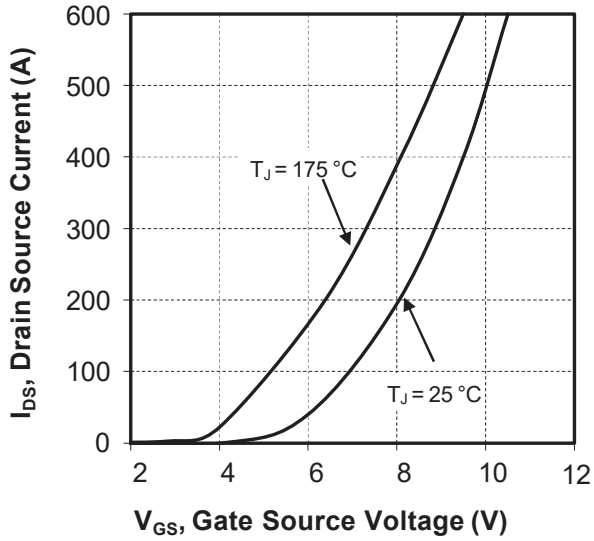


Figure 1-20. Capacitance vs. Drain Source Voltage

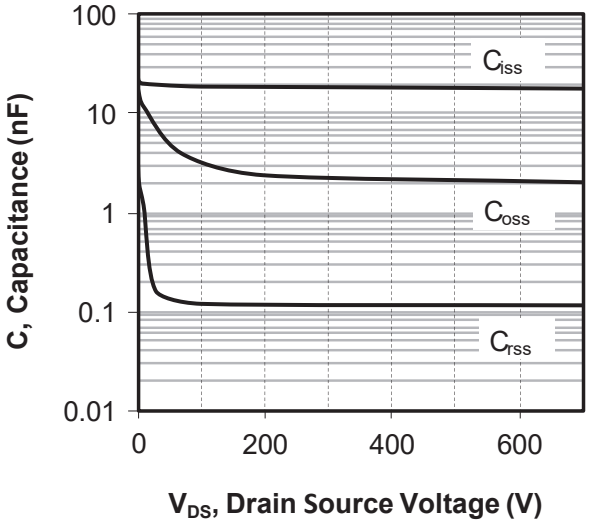


Figure 1-21. Gate Charge vs. Gate Source Voltage

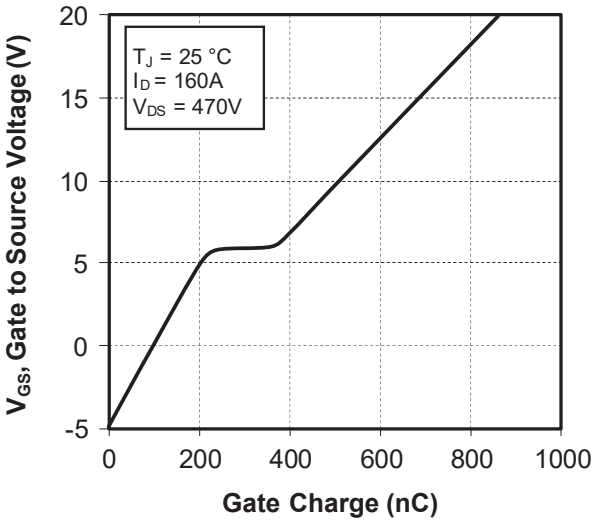


Figure 1-22. Body Diode Characteristics, T_J = 25 °C

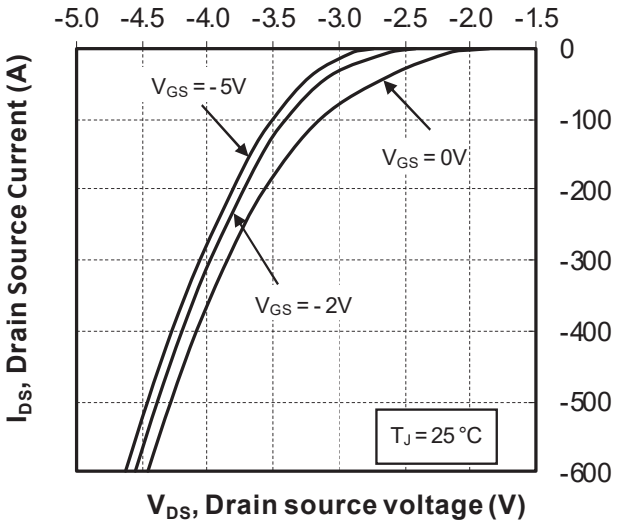


Figure 1-23. 3rd Quadrant Characteristics, T_J = 25 °C

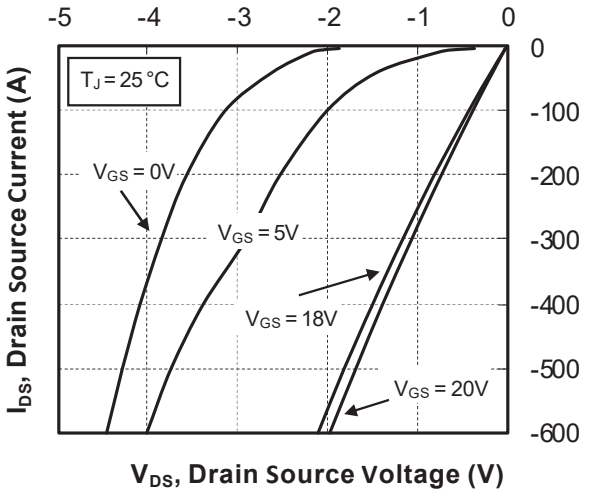


Figure 1-24. Body Diode Characteristics, T_J = 175 °C

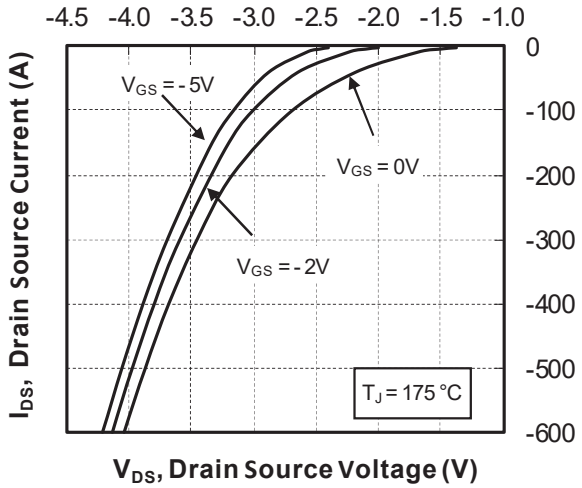


Figure 1-25. 3rd Quadrant Characteristics, T_J = 175 °C

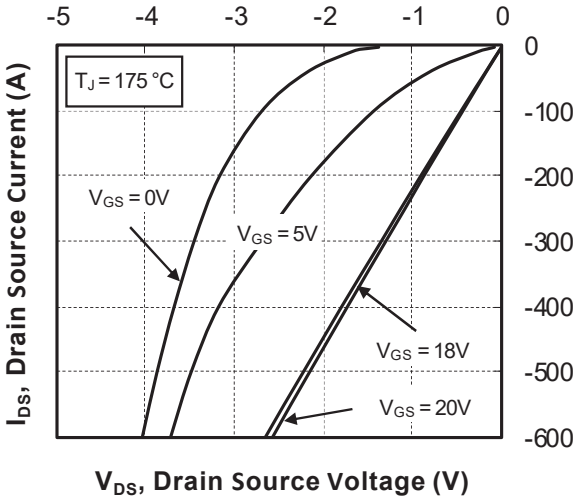


Figure 1-26. Switching Energy vs. Current

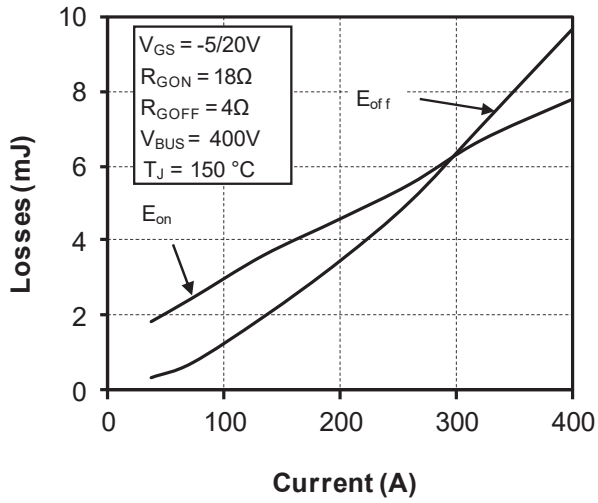


Figure 1-27. Turn on Energy vs. Rg

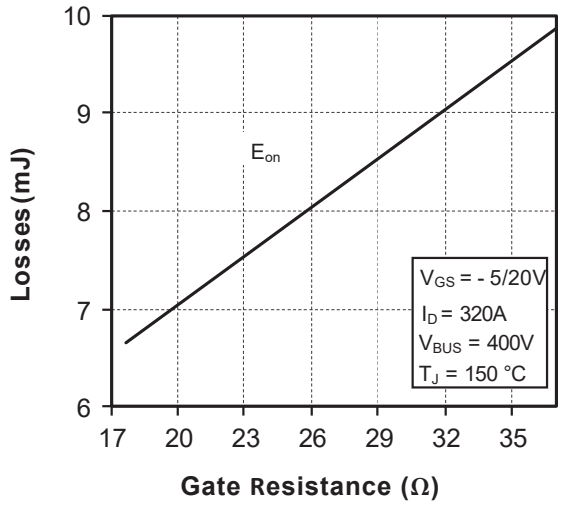


Figure 1-28. Turn off Energy vs. Rg

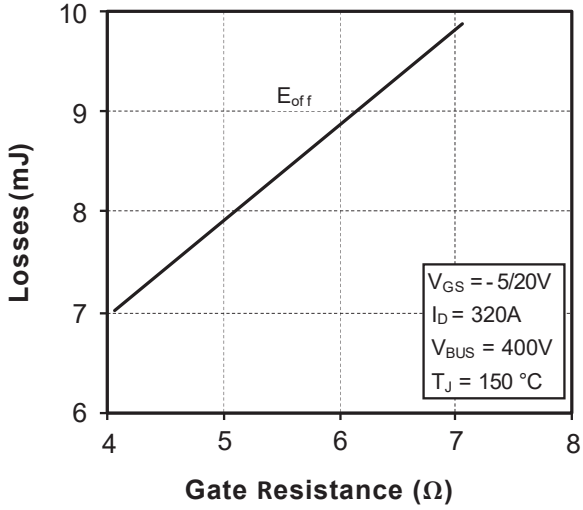
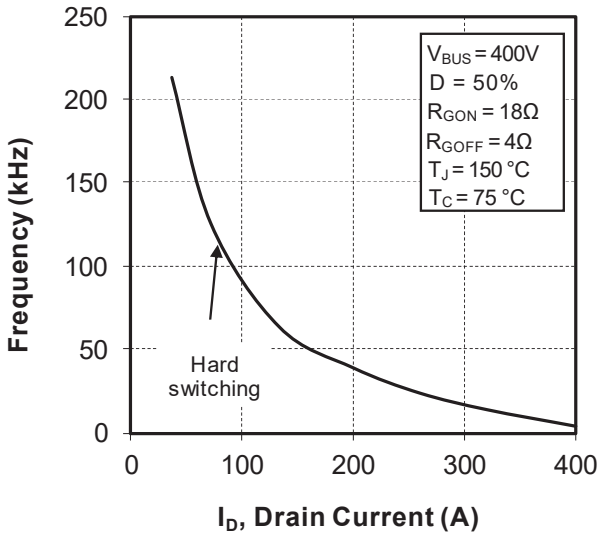


Figure 1-29. Operating Frequency vs. Drain Current



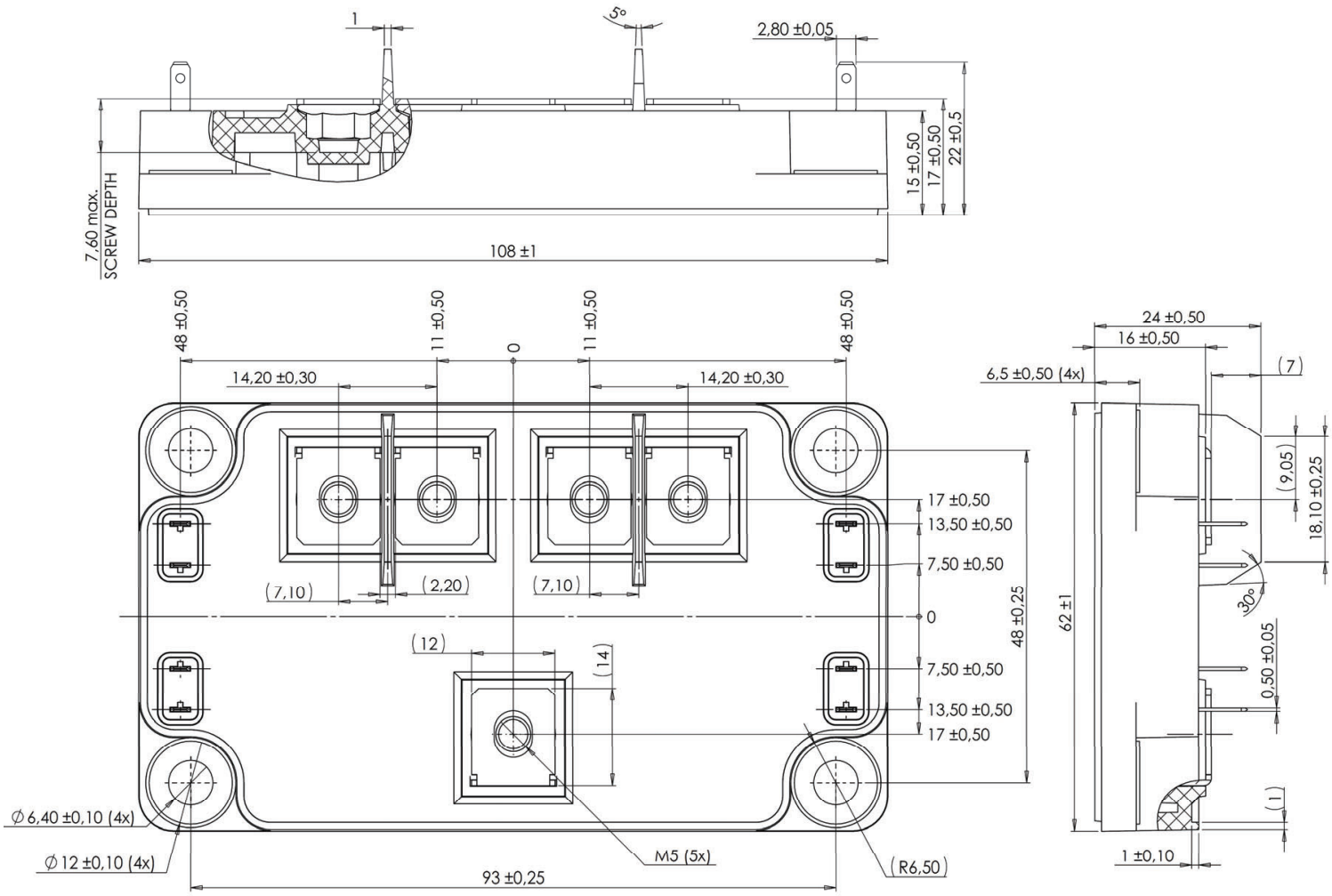
2. Package Specifications

The following section shows the package specification of the MSCSM120HRM052NG device.

2.1 Package Outline

The following figure shows the package outline drawing of the MSCSM120HRM052NG device. The dimensions in the following figure are in millimeters.

Figure 2-1. Package Outline Drawing



3. Revision History

The revision history describes the changes that were implemented in the document. The changes are listed by revision, starting with the most current publication.

Revision	Date	Description
A	02/2023	Initial revision

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ISBN: 978-1-6683-2028-0

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